MapReduce for Repy

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Quick Recap of MapReduce

• Functional programming is powerful!
• Easy to parallelize map() and reduce() passes on data
• Utilizing multiple nodes, a MapReduce implementation must also be fault-tolerance as to not waste work
• Great for pre-computing indices and repetitive tasks
Seattle: The Internet as a Testbed

• A platform for education use for networking and distributed systems research & teaching
• Initiated by Justin Cappos, post doc. at UW
• A time-sharing application similar to SETI@home or Rosetta@home
  – Instead of running only when idle, Seattle uses up to 10% of a machine’s resources (fully-customizable)
    • This include HD space, RAM usage, CPU usage, port usage/binding, thread-spawning, etc..
Users of Seattle can acquire nodes through GENI.

Can use a shell-like interface (seash) to connect to vessels and run Repy code.
Repy ⊂ Python

• Since vessels are not fully virtualized, need to create a safe language
  – Repy aims to be secure, robust, and simple
• Repy limits the use of hazardous calls
  – e.g. bin, callable, delattr, dir, eval, execfile, globals, input, iter, raw_input, reload, staticmethod, super, unicode, __import__
  – Cannot dynamically import code
• Repy provides nice abstracted constructs
  – e.g. sockobj.recv(52) will block until 52 b recv’d
def get_data(ip, port, socketobj, thiscommhandle, listenhandle):
    # get a list of all of our neighbors!
    mycontext['primary'] = recv_message(socketobj)
    print "Primary init thread: got primary loc:", mycontext['pri']

    # we need to know how many peers we have..
    mycontext['num_peers'] = int(socketobj.recv(4))
    print "Primary init thread: got num_peers: ",
        mycontext['num_peers']

    mycontext['peers'] = []
    for i in range(mycontext['num_peers']):
        mycontext['peers'].append(recv_message(socketobj))

    # parse and save data file:
    buf = recv_message(socketobj)
    print "Primary init thread: got file data"
    dataobj = open("map_data.dat", "w")
    dataobj.write(buf)
    dataobj.close()
How does Repy code affect porting MapReduce functionality?

- Code to be imported (e.g. include mapper.repy) must be pre-processed by repypp.py
  - repypp.py simply copies the included file into the current file; skips include loops
    - This isn’t dynamic in the least!
  - Impossible with current Seattle implementation to utilize new map(), partition(), hash(), reduce() methods on the fly
- Since python module pickle can’t be used, have to make serialization from scratch!
How does Repy code affect porting MapReduce functionality?

• Since methods can’t be added dynamically, map-reduce replicas must be initialized with these methods pre-processed

• MapReduce implementation in Repy is not a job manager (e.g. Hadoop), but more like an individual task manager
Primary -> Replica -> Primary

- Simple data pass, no partitioning/collating

- Message sending scheme: 14*128.208.1.121:
  - Size (B)
  - Data
Primary -> n Replicas -> Primary

- Input data split into equal chunks for each peer
  - Another limitation of Repy (no advanced FS ops)
- What happens when a node dies?
  - Wasted work...
- Semi-transitivity of connections will halt all progress
Partitioning

• A lot of python list, set, and dict mutations to arrive at a list of data to send to each node
  – List of (k,v) -> list of h1: (k1,v1,v2), h2: (k2, v3) .. -> list of n1 -> (k1, [v1,v2,v3]), n2 -> ...

• Needs to hold the property that identically hashed keys get shuffled to the same reducer.
Add in some preliminary fault-tolerance..

- Primary keeps a ‘scoreboard’ of replicas
- ACKs implemented to ensure all nodes get initialized
- Peer-peer sockets initialized and retained early
Avenues for fault-tolerance

- Fix semi-transitivity problem by replacing active replicas with inactive ones
- Use a new Repy feature (timeout sockets) to poll for new data or to abort trying after a specified timeout
- Either the primary or any node can request a new node for a downed node.
  - All the primary needs to know is the index of the old node
Since Seattle vessels are distributed across the world, many issues arise:

- Method of selecting ideal node for primary
  - Selection process by central location, proximity to user’s location, lowest ping, lowest avg hop route?
- Variable latency issues
- Semi-transitivity between all nodes + primary
- Bandwidth issues
Demo?

• Three nodes on LAN
  – One primary parses, distributes, scoreboards and aggregates
  – Two nodes map, partition, and reduce data

• Simple word-count example!
Future Work

• Clean up and refactor code
  – This is an early use of Seattle for computational means; it should be a model for new developers!

• Add additional fault-tolerance capabilities, test extensively on Seattle

• Add user-interface – a Seattle node can easily become a webserver *(in 6 lines of Repy!)*
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